Automated monitoring of space=shape data for mfg. semiconductors - compares image signals for defined illumination angle range with master signals, to determine defects

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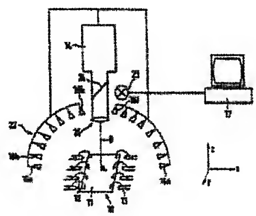
Abstract of **DE 4003983 (C1)**

During the manufacture of semiconductor components, the surface quality of the semiconductor chips and their position relative to a housing and the connecting wires between chip and housing must be monitored. It is proposed that the semiconductor components be illuminated by an illumination device (16a-16n, 23) and observed by means of a camera (14) whose image output signals are fed to an image signal processing device which detects manufacturing defects. Each semiconductor component to be monitored is illuminated at a first reproducible illumination angle, a first set of image signals corresponding to the illuminated semiconductor component is stored, the semiconductor component to be monitored is illuminated at a second reproducible illumination angle, a second set of image signals is stored, the stored sets of image signals are compared with each other and the space-shape data of structures of interest are derived from the difference between the two sets of image signals.The method involves illuminating the components and observing them using a (TV) camera whose signals are evaluated to detect manufacturing defects. The component is first illuminated over a reproducible angle range and a corresponding first set of image signals stored and compared with a further set. Space-shape data of structures of interest are derived from the image signal set differences.



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The invention relates to a method to automatic supervising of spatial form data after the preamble of the claim and/or. an apparatus to the performing the method after the preamble of Claim 17.

A significant problem of the semiconductor industry lies in the fact that the reliability of manufactured components of the manufacturer must become guaranteed. The reliability of the components depends - a correct made chip provided - mainly on the quality of the installation of the chip in the housing. By this are to be understood both the state, in which the chip becomes incorporated, and the layer of the chip in the housing as well as type and quality of the electrical connections between the chip and the housing connection contacts. From this reason a made examination of the chip surfaces on mechanical damages or contamination, the layer of the chip in the housing, the splices between chip and housing as well as the bonding wire connections between the chip and the this inspection becomes so far essentially exclusive performed of human personnel by microscopes. This procedure is arduous to for the personnel and for the entrepreneur cost-intensively, on the other hand is at the today conventional high manufacturing speeds only sampleful examinations of the components possible.

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From the EP 01 59 354 B1 methods and apparatus are that initially mentioned type known. The arrangement shown there is however extraordinary complicated constructed and supplies a so large filling of data, which processed to become to have that even with use of a very quick computer only samples from a production checked to become to be able.

From the DE-OS 24 31 931 it is to be compared known sets of image signals, stored to the determination of spatial form data of semiconductor devices, with other sets from image signals to. In all other respects the thickness of a measuring object becomes by means of an automizable measurement tested in accordance with the teaching of this document, which gives however no very extensively useful information on the data initially specified.

From the DE 38 06 209 A1 a structure defect detection system is known, which is more applicable for an integrated semiconductor circuit for example. With this system supplies a camera picture output signals, which become in picture signal processing means detected and shown on a monitor.

The invention is the basis the object to train methods and apparatus further that initially mentioned type going by since in a simple manner the substantial data are to the recognition of faults with the production of semiconductor devices derivable and examinable.

This object becomes by in the flagstone of the claim 1 and/or. 17 indicated features procedure-moderate and/or. device-moderate dissolved.

A substantial point of the invention lies in the fact that only those image signals and/or. Image points, to which the image signals correspond, observed become, which for the examination relevant is.

A frequent error cause lies in an incorrect formation of the bonding wires. In particular it can do relative easy happens that bonding wires correct not bent or at prolonged formed is, so that they exceed when late pouring the component over the potting compound. In order to examine this, one can light up the semiconductor devices from a variety of directions and win with fixed camera corresponding sets of image data. Here the made illumination from directions, which essentially lies in a plane with the courses of the bonding wires. From the image signals the positions of light reflection places become derived, which develop on the bonding wires. This is possible by the fact that the bonding wires exhibit one extremely smooth surface. From the positions of the light reflection places, the lighting direction and the camera and/or. their optical axis becomes the pitch angle of the bonding wires in the reflection places calculated. Over an integration of the pitch angles (over the length of the bonding wires incipient height known at a point) the course becomes and/or. the height of the bonding wires in a direction calculated, which runs essentially vertical to the surface of the chips. The calculated height of each so checked component becomes compared with a target area, so that a component can be selected if the calculated height falls out of the area.

In order to save and increase thus the working speed computer capacity, is it from advantage, if one knows the course of the bonding wires in the image plane of the camera, before the before described three-dimensional measurement becomes made. For this one can define those areas from two sets of image signals, which became gained with different lighting angles, as lanes of the courses of bonding wires in a x-y plane (the corresponding camera image plane), which appear unlighted In both sets of image signals due to a shade throw of the bonding wires. The angle between the two lighting angles so large becomes of course and/or. small chosen that the shadows overlap themselves.

It is also (if necessary additional) possible to light up the semiconductor device coaxial which can be examined to the optical axis of the Kamer whereby this optical axis is essentially vertical aligned to the surface of the chip. The courses of the bonding wires in the x-y plane appear then darker and can over a known pursuit algorithm to determined become. This therefore agitates that the chip surfaces back-reflect the light very strong direct with illumination with unpolarisiertem light total surface into the camera, while the bonding wires reflect the largest portion of the light into other directions.

After such a image analysis step thus only those image data can become as associated light reflection places classified, which lie in the area of the lanes of the bond processes in the x-y plane and stand out regarding their brightness values against the environment sufficient. Thus not only the reduction initially specified of computer capacity but also an increase of fail-safe characteristic are possible.

After the reflection places appear particularly elongated within the range of large radiuses of curvature, it is from advantage, if the calculated pitch angles the surface centers of gravity are only added, in order to be able to win so an exact defined point crowd for the derivation of the high process.

Since one naturally accomplishes the monitoring with a variety of similar semiconductor devices, one can in a learning step (z. B. store those on the basis visual checked components) background image signals and spatial form data as learning data, which can be expected on the average. Here it turns for example around the layer of the chips in the housing, the courses of the splices, their edges of ring around the chips more visible is and the environment of the bonding wires in particular to the chip surface, to an underlying substrate and to the connection contacts of the bonding wires. When being present such average data one can light up the semiconductor devices in a step from a direction, which runs by a plane, which essentially vertical stands on a plane longitudinal by the bonding wires, whereby the lighting direction oblique runs to the chip surface. By this illumination the bonding wires throw a shadow on the underlying layers (chip, substrate). From the courses of the shade throw of the bonding wires and the learning data the course of the bonding wires in a direction calculated who can do the essentially vertical to the surface of the chips runs, thus the height of the bonding wires. These data can become alternative or however additional the initially described measurement values concerning the bonding wire-high used.

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If one aligns the optical axis of the camera essentially vertical to chip upper subject and makes an Illumination essentially coaxial to the optical axls of the camera with unpolarisiertem light, a so reflected proper chip essentially uniform over its whole surface away. One can define now flaws on the chip surfaces by the fact that one the image portions and/or. Image signals picks out, which correspond to a smaller brightness than the surrounding areas. This therefore agitates that both contamination particles and scratches strew on the chip surface the incident light so that the light quantity at these sites, back-thrown Into the camera, become smaller. If one stores now the so gained Image data and makes the illumination in one nächstens step from another angle, then closed can become from the difference image, which type of fault it concerns, since then the different dispersion characteristics of contamination particles and scratches become more discernible. Preferably made here the illumination approximate parallel to the surface of the chip, so that the appearing flaws as contaminants, bright in the difference image, which are definable dark appearing flaw as violations (scratches) of the chip surface.

The learning procedure initially specified, with which the spatial form becomes average data of the semiconductor devices determined which can be examined, is suitable for the segregation of Incorrect components, thus such components, whose spatial form data deviate by more than a predetermined amount from the average data. It Is also in certain mass a control of production machines due to the determined error data possible. So for the example the machine corrected can and/or. regulated become, which glues the chips on the substrate, since for the example an oversized adhesive edge of ring suggests at chip a too high adhesive dosage. Also from the course of the bonding wires rule data for the bond machine can become gained. In each case the gained data can become the segregation of incorrectly produced components used.

A rough examination by means of a learning procedure can become by the fact performed that at least a correct made semiconductor device, better however a group of such, a bottom defined lighting angle and/or. Lighting angle range illuminated and received becomes. From the image data SI lets reflex ranges specify then, which are to be assigned to the bonding wires with correct made components. Soft one then the image data one semiconductor device from these sample image data, which can be examined, then is present with large probability an incorrectly made component. So z. B. would be if the light reflection range of a bonding wire is smaller as normal to proceed from an excessive curvature of the bonding wire. It turns thus with this version of the method around the examination of characteristic reflection samples, which become derived of correct made components.

By the simplified type of the pattern recognition procedure a significant speed increase can be obtained with the examination bottom simultaneous reduction necessary Rechenund memory capacity. The method can be combined also favourably with the more exact examination procedure, with which exact statements over the spatial form data gained become. So z. B. one knows the more time-consuming, more exact method only for each nth component (z. B. each tenth component) accomplish, while the simpler method at each component becomes performed. Thus a minimum control ensured and the simultaneous probability high that a systematic fault (by the more exact method) becomes recognized, is

itself the z. B. by an incorrect inclusively-calibrates works of a machine slow, even if the faults for the simpler method lie within the permissible range.

If one with a color camera works and different lighting directions different colors and/or. different spectral distributions assigns, then other data can become gained from the color signal of the camera. In particular a simultaneous illumination from several can take place, if necessary all interesting directions simultaneous in this case. Each point of reflex can become then the color signal of the corresponding image data corresponding certain lighting directions associated. Here made thus no control of the light sources, on the contrary all informations the image data removed become. In this place are still noted that a bottom "set is to be understood a variety about image data" not only from grey values or color values to, but each individual pixel still other informations, z. B. Data to (random) the weight individual pixels of the etc. added to be can.

A calibration or if necessary also calibration can be accomplished by the fact that one subjects in a method step a sphere known size with reflective surface to the method. There each point of the sphere a known surface angle and/or. a certain radius of curvature to assign is, can calibrating or calibration data gained and stored become, on the basis those in the following construction unit examinations the gained values or image data into absolute values transfers is.

When illumination sources are suitable to single illumination sources, like light emitting diodes or such a thing, or on the other hand in addition, light conductor illuminations, with which the light withdraws to ends of the light conduits (in various positions the mounted are), and the light from a single illumination source into the other ends of the light conduits introduced becomes. In order to manage this controlled (successively), screen devices are suitable.

Further it is possible to plan mirror systems to the illumination. For this for example a cylinder ellipse mirror is suitable, in whose a fuel axle the component which can be examined is and in its other fuel axle a directed radiating linienförmige light source (cylindrical light source also in addition coaxial, rotatable slit diaphragm) arranged. It depends thus essentially on the fact that a reproducible illumination from different angles can take place.

With an other embodiment of the invention, as becomes used on the basis the corresponding method initially indicated, a lighting device, are associated with which the different lighting directions different colors. This can take place over suitable colour filters, which become illuminated of a light source, which at least sends the substantial spectral portions let through by colour filter. Such a colour filter can become the example from a slide film manufactured, with which a standardized chromatic spectrum (from blue ones to red ones) was abphotographiert. If one wants to have a kugelabschnittsförmigen lighting area of ring around the component which can be examined, then all locations can on the kugelabschnittsförmigen colour filter for the derivation of the bonding wire height process, which exhibits the same height (in the optical axis of the camera), which have same color.

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Special embodiments of the invention result from the Unteransprüchen. In the subsequent description preferable embodiments of the invention become near explained on the basis of images. Here show:

Fig. 1 an embodiment of the invention in schematized representation.

Fig. 2 an embodiment of a light conductor illumination;

Fig. Screen windows to the bonding wire localization schematized 3 AC;

Fig. 4 an isometric partial representation of a chip with bonding wire;

Fig. 5 a pattern sketch to the explanation of the bonding wire course measurement;

Fig. 6 A, B other images to the explanation of bonding wire courses;

Fig. 7 an other embodiment of the invention in schematized representation similar after Fig. 1; and

Fig. 8 an isometric scrap view along the line VIII VIII from Fig. 7.

In Fig. 1 is an embodiment of an apparatus to the monitoring of spatial form data with the production of semiconductor devices schematizes shown. This covers a support 22, at which a variety of single light sources is 16a to 16n fastened. The single light sources 16a-16n are preferably in same angular spacings to each other arranged and on a common center directed. The bottom support 22 with the light sources 16a-16n is (not more shown) an holder provided, on whom a semiconductor device which can be examined can become positioned. The semiconductor device is in the drawing 10 indicated by the schematized representation of a chip, its terminals over bonding wires 12 with connection contacts 13 (not shown) of an housing connected is.

Over the semiconductor device (CCD) a camera is 14 so held that the optical axis O of their lens 25 essentially vertical stands on the surface 11 of the chip 10.

The rear lens 25 of the camera 14 a beam splitter is 24 so mounted that a light source 23 arranged beside the camera 14 can light up the semiconductor device coaxial to the optical axis O.

All illumination sources 16a-16n and 23 are located to which in a controlled connection with processing means 17 in addition the picture output signals of the camera 14 supplied become. With this arrangement it is possible to light up that semiconductor device which can be examined successively from different directions the corresponding light sources driven of the processing means 17 and to take up the image signals generated in the camera 14 for subsequent treatment.

In place of the variety of single illumination sources 16a-16n it is possible to fasten light conduits with first ends in the holder 22 in whose other ends light irradiated becomes. A suitable arrangement is (in representation in principle) in Fig. 2 shown. The ends of the light conduits L1-L5 shown there are in (not shown) an holder so fastened that they on a circle (-portion) lie. A light source 21 is provided, which light sends L1-L5 in the direction of the ends of the light conduits. Between the light source 21 and the end surfaces of the light conduits a disk shaped diaphragm is 19 provided, which is more rotatable by means of (walking) a motor 20. In the diaphragm is an aperture, which is so formed that the light emitted of the light source 21 can fall depending upon position of the diaphragm 19 in each case on the end surface one the light conduit L1-L5, depending upon position of the pinhole 19. The circle (portion), on which the ends of the light conduits positioned is, corresponds naturally to the path of the hole in the diaphragm 19.

To the explanation of the initially made description of the invention process is the accompanying Fig. 4 serves. This shows a semiconductor device in schematized representation, 15 mounted (glued on), with which a chip is 10 on a substrate. Connection contacts on the surface 11 of the chip 10 are 13 connected over bonding wires 12 with connection contacts, which are connected with outward (from the housing) rising up contact pins (not shown). Each bonding wire 12 becomes resultant between the corresponding port on the chip 10 arc shaped from the actual known bond procedures and the contact 13 guided, so that the bonding wire 12 essentially in a plane A runs, which stand for essentially vertical on the surface 11 of the chip 10. The surface 11 runs in a x-y plane, the bonding wires extends thus in a direction Z upward over the surface 11 of the chip 10 outside.

Illuminated one one now such a bonding wire 12 from a certain, in Fig. 5 with approximately 10 DEG the surface 11 of the chip 10 assumed angle, then becomes, as in Fig. 5 shown, due to the curvature of the bonding wire 12 only smaller, a small surface section of the bonding wire 12 corresponding portion of the irradiated light in (the lens) camera 14 reflected, the remaining light portions become radiated into other directions. Since the roughness is small the bonding wire-upperflat, only small scattered light portions of other bonding wire sections arrive into the camera. Since the angle of incidence is the same loss angle of the light rays and the relative positions of the luminous in each case light source are 14 known to the camera, the angle can become certain, in which the surface section of the bonding wire 12 runs, that the light into the camera 14 reflected. If one lets a light source 16a-16n light up now after the other one the bonding wires 12, then successively different points on the bonding wires 12 can become regarding their angle the surface 11 of the chip 10 certain, whereby one over an integration of the angles and/or. the associated locations on the bonding wires 12 their course in Z-direction to calculate can.

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This circumstances again are in the Fig. 6A and 6B explained, whereby the Fig. 6A a correct bonding wire course and Fig. 6B an incorrect bonding wire course show. From this images comes out also that the areas, in which the bonding wires light reflect into the camera exhibit different linear extension depending upon radius of curvature, from which again data are derivable, which for the quality inspection used to become to be able. In particular it is possible to win bottom application of a learning procedure at correct made semiconductor devices over the judgment of the reflex zones at different sites of the bonding wires sufficient safe data over it whether the bonding wires a correct course (Fig. 6A) or an incorrect course (Fig. 6B) exhibit.

In order to be able to find the reflex places out on the bonding wires easier from the image data, it is from advantage, if the courses of the bonding wires are in the x-y plane known. In order to find these courses out, one can light up the bonding wires from two different angles, which are preferably symmetric around the optical axis O of the camera arranged. The two resultant images are schematized in Fig. 3A and/or. 3B shown. Arise then for each of the images a brightness sample 26 for the ground, a brightness picture 28 for the area, in which the respective bonding wire 12 reflected, and a brightness sample 27, which correspond to a shadow, which the respective bonding wire throws on the ground. One forms a difference between the images after Fig. 3A and Fig. 3B, then results the image after Fig. 3C, with which (dark) the shade range 27, that with the two images after Fig. 3A and 3B at the same site (in the x-y plane) lie, high-contrast opposite (brighter) the background step out. In the area these "shade-purely" of the bonding wires must lie then the reflection zones (in the x-y plane), those for Höhenbestimmung (see Fig. 5 and 6) to be consulted. Thus a data reduction can be obtained to the simplification and acceleration of the information processing. It is of course also possible, if the bonding wire courses in the x-y plane deviate very far from a target course to select the associated semiconductor devices as incorrect.

In the following an other preferable embodiment becomes on the basis the Fig. 7 and 8 near described.

With this embodiment is in place of a variety of light sources 16a-16n out several white light sources 31 an existing illumination unit provided, whose light becomes by in, in a support 22 mounted colour filters 32 on the chip which can be examined 10 sent. Colour filter 32 is so designed that each lighting direction is a defined color associated. For example that knows colour filter 32 in the Fig. 7 and 8 the chromatic spectrum from blue ones to red ones goes through from downside upward. It arrives only on it that each direction, becomes 10 illuminated from which the chip can become a particular color associated.

The camera 14 is formed as color camera, so that from its output signal can become gained over a color modem 30 a signal (analogous or digital), which assigns a color value to each image point. This then the processing means 17 supplied color value corresponds to a certain lighting direction.

The arrangement after Fig. 7 understood can become also as section by a hollow-spherical lighting device (with camera), whereby then colour filter is preferably achsensymmetrisc to the optical axis the O of the camera 14 formed. With this embodiment of the invention a simplification is in as much more achievable as no separate drive different light sources must take place more.

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1. Methods to the automatic monitoring of spatial form data with the production of semiconductor devices, observed with which the semiconductor devices become by means of a lighting device (16) illuminated and over a camera (14), their picture output signals of picture signal processing means (17) for recognizing Herstellungsfehlern supplyable are, whereby the semiconductor device which can be examined becomes bottom at least a first reproducible lighting angle area illuminated, at least
a set of image signals the corresponding illuminated semiconductor stored becomes, those
stored sets an other set of image signals compared, stored by image signals with, become and
from the discriminated ones of the sets of image signals spatial form data of interesting structures derived will become, characterised in that the illumination of the semiconductor devices with fixed camera from a variety of directions of made and from this corresponding sets of image data gained.

2. Process according to claim 1, characterised in that the other stored set of image signals a set of sample image signals corresponds, which became gained of one or an averaged variety of correct made semiconductor devices.

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3. Process according to claim 2, characterised in that the semiconductor device which can be examined discarded becomes if a set deviates from image signals in layer and/or size from light reflection places by a predetermined amount (scattering range) from the set from sample image signals.

4.Verfahren according to claim 3, characterized thereby,
that to supervising bonding wire connections (12) with connection contacts (13) on semiconductor chips (10) the illumination from directions made, which essentially lies in a plane (A) with the courses of the bonding wire (12) that the position of light reflection places resultant on the bonding wires (12) from the image signals derived become,
that from the positions of the light reflection places, the lighting direction and the camera pitch angles of the bonding wires in the reflection places become calculated; and
that becomes calculated over an integration of the pitch angles the course of the bonding wires in a direction (Z), which runs essentially vertical to the surface of the chips.

5.Verfahren according to claim 4, characterised in that from two sets of image signals, which become gained with different lighting angles, those areas as lanes of courses of bonding wires (12) in a x-y plane defined become, which appear unlighted in both sets of image signals due to a shade throw of the bonding wires (12).

6. Process according to claim 4, characterised in that in a step the semiconductor device coaxial to the optical axis (O) of the camera (14), which can be examined, illuminated becomes, which is essentially vertical to the surface (11) of the chips (10) aligned and which become courses of bonding wires (12) into a x-y plane by means of an edge pursuit algorithm of dark linienförmig longitudinal image signals determined.

7.Verfahren after one of the claims 5 or 6, characterised in that only those image data as associated to light reflection places classified become, which lie in the area of the lanes of the bonding wire courses in the x-y plane and stand out regarding their brightness values against the environment sufficient.

8.Verfahren according to claim 4, characterised in that to the brightness resultant surfaces of the light reflection places of centroids calculated essentially same from contiguous image signals and the errecnneten pitch angles these points associated become.
9 methods after one of the preceding claims, characterised in that with a monitoring of a variety of similar brightness ranges in a learning step those background image signals and spatial form data as Lernd stored, which can be expected on the average, become, the which chip surface (11), comprising to the environment of bonding wires (12), an underlying substrate and connection contacts (13) for the bonding wires (12), to belong.

10. methods according to claim 9, characterised in that the semiconductor devices in a step from a direction illuminated become, which runs by a plane (B), which vertical plane (A) longitudinal on one by the bonding wires (12) stands,

whereby the Beleuchtungsrichrung oblique runs to the chip surface (11), and that from courses of a shade throw of the bonding wires (12) and the learning data the course of the bonding wires (12) becomes calculated into a direction (Z), which runs essentially vertical to the surface (11) of the chips (10).

11-method according to claim 1, characterized thus,
that the illumination of semiconductor chips (10) essentially vertical to the chip surface (11) coaxial to the optical axis (O) of the camera (14) with unpolarisiertem light made and
that defined in a step those sites on the surface (11) of a chip (10) become as flaws, their associated image signals a smaller brightness represent than surrounding areas.

12.Verfahren according to claim 11, characterised in that the illumination in a next step in an acute angle approximate parallel to the surface (11) of the chip (10) made, a difference image from the before gained set of image data and the instantaneous image data generated becomes and the appearing flaws bright in the difference image as contaminants, which become dark appearing flaws as violations of the chip surface (11) defined.

13.Verfahren after one of the preceding claims, characterised in that in a learning procedure the average of the image signals the corresponding relative position of the chips (10) to the housing and/or the courses of areas around the edges of the chips (10), covered with adhesive, determined will and an error signal generated becomes if the instantaneous gained image signals deviate by predetermined values from the averages of the image signals.

14. Method after one of the preceding claims, characterised in that the spectrum of the lighting up light in dependence of the lighting angle set is, and that from a color signal of the camera single image signals belonging lighting angle becomes derived.

15. Process according to claim 14, characterised in that the illumination simultaneous bottom different lighting angles performed becomes.

16. Methods after one of the preceding claims, characterised in that in a calibration step a sphere known size the method subjected and from the image signals of calibration values gained and stored become.

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17.Vorrichtung to the performing the method after the claims 1 to 16, with a lighting device (16) to the illumination of the semiconductor devices (10), a camera (14) to the image pickup and picture signal processing means (17) to the recognition of Herstellungsfehlern of the semiconductor device (10), characterised in that the lighting device (16) such a formed and semiconductor device which can be examined to one arranged is that this with fixed camera bottom at least two from each other different reproducible angles is illuminable.

18. Apparatus according to claim 17, characterised in that the lighting device (16) a variety of single illumination sources (16a-16n) covers.

19.Vorrichtung according to claim 18, characterised in that all single illumination sources (16a-16n) essentially same of a point remote are far, in which the semiconductor device which can be examined is positionable.

20. Apparatus according to claim 18 or 19, characterised in that the single illumination sources (16a-16n) light emitting diodes cover.

21. Apparatus according to claim 18 or 19, characterised in that the single illumination sources (16a-16n) first ends of light conduits (18) covers, into whose second ends temporal successively by screen mechanisms (19) light from a single light source (21) is importable.

22.Vorrichtung according to claim 17, characterised in that the lighting device (16) an cylinder-annular or kugelabschnittsförmige light-send-flat (29) covers, which is in such a manner formed that different sites are the light-send-flat different flash spectra associated, and that the camera (14) formed to the generation of image signals is, cover the color signals.

23. Apparatus according to claim 22, characterized by a mechanism (30), which a chrominance signal from a television color camera into a signal converts, its different values the different sites of the light-send-flat (29) and/or. correspond to different lighting angles.

24. Apparatus after one of the claims 22 or 23, characterised in that the lighting device (16) a wide-band light source (31) and a colour filter (32) also over the surface changing colors or light pass bands covers itself.